ELECTRICAL SENSOR OF PLANE COORDINATES

BACKGROUND OF THE INVENTION

The electrical sensing of information relating to plane coordinates has heretofore been carried out with many forms of apparatus, but which, so far as we are aware, have been characterized by the use of relatively complex and expensive equipment. As an example of such information, one having a function F (x,y) in graphical form may wish to replot that function with linear or non-linear scale changes; or to divide or multiply the function by another function G (x,y); or to differentiate F (x,y), or to integrate F (x,y); or to read F (x,y), or the operations of dividing, multiplying, integrating or differentiating the same, into a digital computer paper tape, magnetic tape or other memory.

The use of single sheets of conductive material, such as paper or conducting plastics of uniform resistivity suitably activated electrically, over which a probe may be selectively moved in contact with the sheet and through which probe a signal may be transferred to an information-indicating unit, is well known in the techniques of plotting electrical fields.

Likewise, the use of such a single sheet and a probe through which a signal is transmitted is taught in Poland Pat. No. 3,355,692 disclosing a function generator wherein the function F (x,y) is manifested by an electrical potential corresponding to the point at which the probe touches the single sheet and with the probe being moved by servomotors.

Moreover, in Peek U.S. Pat. No. 2,907,824 an electrographic transmitter is shown in which a magnetic stylus manually movable over juxtaposed electrically charged separate windings causes the windings to touch each other and to transmit signals therefrom which correspond to the x and the y coordinates of these windings at the point of such stylus touching. However, in this arrangement the physical movement of the loose winding toward the tight winding under the influence of the magnetic stylus requires elaborate insulation details and careful spacing of many wires per inch to achieve resolution. These, of course, contribute to the high cost of the apparatus.

In contrast, therefore, with such conventional apparatus as above mentioned the present invention employs inexpensive sheets of insulation and of conducting material, together with a simple electrical circuit and a simple probe.

SUMMARY

The invention employs the combination of a pair of conductive sheets having a uniform restivity throughout and with these sheets being insulated from each other and juxtaposed so that equipotential lines extending across the respective sheets or orthogonal to each other. Each sheet is an element of a simple electrical circuit and these circuits are floating with respect to each other and with respect to ground. Each sheet has extending therefrom an individual conductor, adapted to be connected to an information-indicating unit and through which conductors separate signals may be carried between the sheets and the unit when the sheets are touched by a movable probe.

Among the objects of the invention are the provision of a simple electrical sensor of plane coordinates using inexpensive materials and simple electrical circuitry; the provision of a sensing apparatus which may be readily assembled or disassembled; this provision of a sensing apparatus which may be readily modified by the addition of inexpensive metallic sheets and insulating sheets to adapt the same to use with different types of information-indicating units; and the provision of a sensing apparatus adapted for use with a variety of movable probes.

These and other advantages and objectives of the invention will become more apparent as the description proceeds and when considered in conjunction with the accompanying drawings in which:

FIG. **1** is a schematic diagram illustrating potential relations with respect to a single sheet of conductive material as employed with the invention.

FIG. **2** is a schematic view of two cooperating sheets of conductive material employed with the invention.

FIG. **3** is a perspective and partially broken-away view of a supporting member on which a stack of readily removable sheets are mounted for carrying out the sensing operation, and illustrating the simplicity of the apparatus.

FIG. **4** is a diagrammatic view illustrating an arrangement of sheets in a second form of apparatus.

FIG. **5** is a diagrammatic view illustrating a sheet arrangement with a modified form of probe in a third form of apparatus and

FIG. **6** is a diagrammatic view illustrating an arrangement of sheets in a fourth form of apparatus.

Referring now to FIG. **1**, a single sheet **100** of uniformly conducting material insulated from ground and when provided with strip electrodes **11**, **12** equally spaced along their length from each other by the distance A and connected to the terminals of a battery **13**, may serve for the x coordinate information source. Accordingly, the potential at a point P (x,y) is proportional to x and is independent of y since equipotential lines extend across the sheet for any given x value. The potential, therefore, at the point P (x,y) is

$$Vo+\frac{x}{a}Va$$

and the potential difference $Vxy - Vo$ is

$$\frac{x}{a}Va$$

If, therefore, the sheet is suitably grounded at P and has a conductor **18** extending from electrode **11** to an information-indicating unit, a signal proportional to the potential difference

$$\frac{x}{a}Va$$

will be impressed on that unit and may be usefully employed. When the ground is later removed, the sheet, moreover, is again restored to its normally insulated condition.

Also if a second similar sheet **14** (FIG. **2**) is disposed orthogonally with respect to and insulated from the sheet **10** and ground, and having battery **15** connected to its electrodes **16**, **17**, its potential at point P (x,y) will be proportional to y and will be independent of x since it likewise has equipotential lines for any given y value. As will be noted, the two sheets **10** and **14** may be described as floating with respect to ground and to each other. As a result when a grounded probe touches each sheet at point P, sheet **10** will be grounded at x and sheet **14** will be grounded at y causing a signal Sx to be impressed between conductor **18** and ground, and a separate signal Sy to be impressed between conductor **19** and ground. These respective signals, moreover, are proportional to the coordinate x and to the coordinate y as represented by the single point P.

Passing now to FIG. **3**, one simple form of structure in which the invention may be embodied includes a box-like housing **20** having a flat upper surface on which the pack of sheets may be spread and with any suitable means (not shown) for detachably holding the juxtaposed sheets in proper position. Conveniently, the batteries may be housed within the structure and the upper surface of the assembly is unobstructed in order to permit easy manipulation of the probe **21** which in the form here illustrated is connected to ground by an elongated extensible conductor **22**.

Such an assembly includes a sheet **22** of electrical insulating material resting on the upper surface of the housing and supporting thereabove one of the sheets of conductive material, here illustrated as the sheet **14** for the y coordinates and having its equipotential lines indicated by dotted lines. Resting on the upper surface of sheet **14** is a second sheet **23** of insulating material and resting on this second sheet is the sheet **10** of conducting material providing the x coordinates and also having its equipotential lines indicated by dotted lines. As will be